

Self-Study 1

Clinical scenario:

An elderly couple had been in reasonable health until the weather turned cold that fall. For the first time that season, they turned on the furnace and closed the windows in the house. When their son visited them for the first time in 2 days, he noticed that they were complaining of headaches, confusion, fatigue, and some nausea. On arrival at the emergency department, both patients were afebrile with normal vital signs and oxygen saturation of 99 percent. Their lips appeared to be very red. Both patients were slightly confused but otherwise oriented. The physical examinations were within normal limits. Based on their living circumstances and examinations, the preliminary diagnosis was carbon monoxide poisoning.

Learning issues:

1. What are the symptoms of carbon monoxide (CO) poisoning and how is it diagnosed?

Acute/ Initial: headache, nausea, malaise, fatigue, flu-like symptoms, confusion, lightheadedness

Chronic/ Prolonged: depression, confusion, memory loss, strange gait, cortical blindness, speech disturbances, vomiting, chest pain

Diagnosis:

There are many conditions to be considered in the differential diagnosis of carbon monoxide poisoning. The earliest symptoms, especially from low level exposures, are often non-specific and readily confused with other illnesses, typically flu-like viral syndromes, depression, chronic fatigue syndrome, chest pain, and migraine or other headaches.

A CO-oximeter is used to determine carboxyhemoglobin levels. Pulse CO-oximeters estimate carboxyhemoglobin with a non-invasive finger clip similar to a pulse oximeter. These devices function by passing various wavelengths of light through the fingertip and measuring the light absorption of the different types of hemoglobin in the capillaries.

2. What are the major protein targets bound by CO and the physiological effects of this binding?

CO can be bound to Hemoglobin, Myoglobin, and Cytochrome oxidase. CO has a higher diffusion coefficient compared to oxygen. Hemoglobin's affinity for CO is about 230 times stronger than O₂. Therefore, hemoglobin will bind to CO over O₂. CO competes for the binding site on hemoglobin, and locks the hemoglobin in the R-state preventing the release any O₂. As a result, O₂ saturation levels will be high.

CO has about 60 times greater affinity for myoglobin than O₂. CO bound to myoglobin impairs myoglobins' ability to utilize oxygen. This causes reduced cardiac output, hypotension, which may result in brain ischemia.

CO can also bind to cytochrome oxidase which can interfere with aerobic metabolism and ATP synthesis.

3. How would you differentiate between CO poisoning and flu in terms of symptoms and onset in different family members?

- You feel better when you are away from your home.
- More than one person in the home gets sick at the same time (it usually takes several days for the flu to pass from person to person).
- Family members who are most affected spend the most time in the home.
- Symptoms occur or get worse shortly after turning on a fuel-burning device or running a vehicle in an attached garage.
- Indoor pets also appear ill, exhibiting symptoms such as drowsiness and lethargy (human flu viruses are not transmitted to pets)
- You don't have generalized aching, low-grade fever, or swollen lymph nodes (these are typical of a cold or flu).

4. Compare similarities and differences between CO and cyanide poisoning in terms of symptoms, mechanisms, and treatment.

Cyanide poisoning occurs when a living organism is exposed to a compound that produces cyanide ions (CN^-) when dissolved in water. Common poisonous cyanide compounds include hydrogen cyanide gas and the crystalline solids potassium cyanide and sodium cyanide. The cyanide ion halts cellular respiration by inhibiting an enzyme in mitochondria called cytochrome c oxidase.

	Carbon Monoxide	Cyanide
Symptoms Similar	confusion, shortness of breath, headache, poor coordination, nausea, general weakness, excessive sweating, vomiting, drowsiness, seizures, sudden collapse, coma, possible death	confusion, shortness of breath, headache, poor coordination, nausea, general weakness, excessive sweating, vomiting, drowsiness, seizures, sudden collapse, coma, possible death
Symptoms Different	Hydrogen cyanide inhalation will result in difficulty breathing, the person is gasping for air even when he/she is brought out to fresh air.	Carbon monoxide poisoning will result in the person feeling sleepy, but breathing is normal.

Carbon Monoxide prevents the release of oxygen from hemoglobin and binding to cytochrome oxidase interferes with aerobic metabolism and ATP synthesis.

Cyanide Poisoning inhibits the enzyme cytochrome c oxidase in the mitochondria, thus stopping cellular respiration.

Carbon Monoxide Poisoning Medical Treatment

- The treatment for carbon monoxide poisoning is high-dose oxygen, usually using a facemask attached to an oxygen reserve bag.
- Carbon monoxide levels in the blood may be periodically checked until they are low enough to safely send the patient home.
- In severe poisoning, if available, a hyperbaric pressure chamber may be used to provide even higher doses of oxygen to the patient.
- It is important to find the source of the carbon monoxide. A local fire department or public service company will help find the source of carbon monoxide and make sure the building is safe.

Cyanide Poisoning Medical Treatment

- If the patient is completely unconscious, all attempts will be made to save the person's life. A variety of invasive measures may need to be performed on the patient in order to closely monitor and evaluate the person.
- If the patient's condition is not grave, he or she will need a thorough investigation. Typically, the patient's clothes will be removed because leftover cyanide on clothing can continue to poison both the patient and those providing care.
 - The patient may also have his or her stomach pumped if a recent ingestion of cyanide-containing substances is suspected. This is done by placing a tube down the mouth and into the stomach, followed by a thorough washing out of the stomach.
 - A Cyanide Antidote Kit (CAK) or Hydroxocobalamin (Cyanokit) may be used if a strong suspicion for cyanide poisoning exists. Although not 100% successful, these antidotes can often prevent the cyanide from further poisoning the victim.
 - If the person has carbon monoxide poisoning as well, hyperbaric oxygen therapy may be used if available. This requires placing the person in a special chamber that will give an extremely high amount of oxygen. Controversy still exists as to hyperbaric oxygen's definite role in the treatment of carbon monoxide poisoning.
- If it is determined that the risk of actual cyanide ingestion is very low, the patient may be monitored for a few hours. If the patient appears well enough, he or she may be sent home with careful instructions to return immediately if any of the previous signs or symptoms develop.